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FINAL SCIENTIFIC REPORT

Grant No. AFOSR-8 -0086

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Light Scattering of Spectroscopy of Semiconductors

Period covered: January 1, 1982 - March 30, 1983  
with a 3-month no-cost extension

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This report covers the period between January 1, 1982 and March 30, 1983. The original grant period which was to end on December 31, 1982 was extended at no cost to March 30, 1983.

### I. Research Objectives

The main objective of this project is to investigate the properties of technically important semiconducting materials in terms of the elementary excitations that determine their optical and electrical characteristics. In particular the properties of these materials near the surface are to be investigated by measuring the dispersion of surface polaritons by means of Raman scattering spectroscopy.

### II. Significant Accomplishments

Raman spectra of guided-wave-polaritons (GWP) and surface polaritons (SP) in the layered compound GaSe were measured. The sample thickness ranged between 2 microns and 7 microns. A complete set of dispersion curves for GWP and SP was obtained from the Raman data for several film thicknesses. The dispersion curves agree well with the theoretical predictions based on the dielectric constant of bulk GaSe with slight modifications in its value. As a result an accurate value of the dielectric constant parallel to the c-axis was obtained. The Raman scattering intensities of different GWP and SP branches could be fitted using only one adjustable parameter corresponding to the absolute cross-section. This was possible, evidently because of the smoothness of the cleaved sample surfaces.

Raman scattering intensities of GWP in thin slab samples of GaP were measured with and without a grating on the surface. The

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comparison of the intensities showed that the scattering intensity is increased by the presence of a grating. The cause for the observed enhancement of intensities by a grating is being sought, but no definitive conclusion about the mechanism has been reached.

Raman scattering mediated by surface plasmon polaritons (SPP) at the incident light frequency was measured, using a silver film of thickness 400 angstroms evaporated on the flat surface of a semi-spherical prism. This measurement shows that the Raman signal is enhanced by a factor of  $10^4$  in this method. This method can be applied to investigate the behavior of solids or molecules in contact with the surface of a metal. The highly enhanced electromagnetic fields at the surface can be used to induce non-linear optical phenomena using a relatively low incident laser power.

Raman scattering spectra of doped GaAs films grown on a sapphire substrate by MOVPE were investigated to observe the surface-plasmon LO-phonon coupled modes. The data show that there are not sufficient carriers in the samples investigated so far.

#### IV. Publications

1. Guided-wave polaritons in thin films of the layered compound GaSe, Y. Sasaki and S. Ushioda, Phys. Rev. B27, 1122 (1983).
2. Raman scattering mediated by surface-plasmon polariton resonance, S. Ushioda and Y. Sasaki, Phys.Rev. B27, 1401 (1983).

3. Raman scattering by surface polaritons in doped GaAs films grown by MOVPE, D. Walsh, R. M. Pierce and S. Ushioda, APS Bulletin 28, 491 (1983).
4. Grating enhancement of Raman scattering from surface and guided-wave polaritons, R. M. Pierce and S. Ushioda, APS Bulletin 28, 527 (1983).

V. Coupling

Collaborative arrangements were made with

- 1) P. W. Kruse and M. A. Kahn, Honeywell Corporate Materials Sciences Center.
- 2) R. Reinisch and M. Nevriere, ENSIEG, Grenoble.

VI. Patents                      None